### Preparer Information

<table>
<thead>
<tr>
<th>PrepName_1A</th>
<th>PrepEmail_1B</th>
<th>PrepPhone_1C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russell W Perry</td>
<td><a href="mailto:rperry@usgs.gov">rperry@usgs.gov</a></td>
<td>(509) 538-2299 x242</td>
</tr>
</tbody>
</table>

### Project Information

<table>
<thead>
<tr>
<th>ProjectNo_2C</th>
<th>ProjectTitle_4</th>
</tr>
</thead>
<tbody>
<tr>
<td>R/SF-20</td>
<td>Estimating route-specific survival and distribution of juvenile salmonids migrating through the Sacramento-San Joaquin River Delta</td>
</tr>
</tbody>
</table>

### CALFed Fellow contact information

<table>
<thead>
<tr>
<th>FelTitle_5A</th>
<th>FelLast_5B</th>
<th>FelFirst_5C</th>
<th>FelInit_5D</th>
<th>FelStreetAddr_5G</th>
<th>FelCity_5H</th>
<th>FelState_5I</th>
<th>FelZip_5J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr.</td>
<td>Perry</td>
<td>Russell</td>
<td>W</td>
<td>1122 NE Boat St</td>
<td>Seattle</td>
<td>WA</td>
<td>98105</td>
</tr>
</tbody>
</table>

### Research Mentor (for additional please see #8)

<table>
<thead>
<tr>
<th>RMTitle_6A</th>
<th>RLLastName_6B</th>
<th>RMLFirstName_6C</th>
<th>RMInit_6D</th>
<th>RMStreetAddr_6G</th>
<th>RMCity_6H</th>
<th>RMState_6I</th>
<th>RMZip_6J</th>
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</thead>
<tbody>
<tr>
<td>Dr.</td>
<td>Skalski</td>
<td>John</td>
<td>R</td>
<td>1325 4th Avenue, Ste 1820</td>
<td>Seattle</td>
<td>WA</td>
<td>98101-2509</td>
</tr>
</tbody>
</table>

### Community Mentor (for additional please see #9)

<table>
<thead>
<tr>
<th>CMTitle_7A</th>
<th>CLLastName_7B</th>
<th>CMFirstName_7C</th>
<th>CMInit_7D</th>
<th>CMStreetAddr_7G</th>
<th>CMCity_7H</th>
<th>CMState_7I</th>
<th>CMZip_7J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ms.</td>
<td>Brandes</td>
<td>Patricia</td>
<td>L</td>
<td>4001 N. Wilson Way</td>
<td>Stockton</td>
<td>CA</td>
<td>95205</td>
</tr>
</tbody>
</table>

### Additional Research Mentors and Community Mentors

<table>
<thead>
<tr>
<th>Additional Research Mentors_8</th>
<th>Additional Community Mentors_9</th>
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<tbody>
<tr>
<td>Dr. Jon Burau, Engineer</td>
<td>Dr. Steven T. Lindley, Ecologist</td>
</tr>
<tr>
<td>U.S. Geological Survey</td>
<td>8604 La Jolla Shores Drive</td>
</tr>
<tr>
<td>6000 J Street - Placer Hall</td>
<td>La Jolla, CA, 92037-1508</td>
</tr>
<tr>
<td>Sacramento, CA 95819-6129</td>
<td>(831) 420-3921</td>
</tr>
</tbody>
</table>
My primary objective is to develop a mark-recapture model that will estimate parameters of population distribution through the Delta, survival probabilities of juvenile salmonids traversing different migratory pathways, and overall survival probabilities of the population migrating through the Delta.

Additional objectives include:
1) Collaborating with community mentors to design the telemetry system needed to implement the mark-recapture model.
2) Estimating survival, detection, and migration distribution of juvenile salmonids through the Delta.
4) Performing sample size and power analysis to aid in design of studies with the necessary precision required for sound management decisions.
5) Conducting simulation experiments to aid in understanding the complex physical and biological processes that govern population distribution and survival through the Delta in response to water management actions.

During the first year of this project, I worked directly with Jon Burau and Pat Brandes to design mark-recapture models for telemetry studies they conducted during the winter of 2006/2007. First, I worked with these researchers to design and implement a telemetry system necessary for estimating survival and movement of fish through the Delta. Then based on this design, I developed mark-recapture models to estimate 1) survival through specific reaches of the Delta, 2) the proportion of fish using specific migration routes such as Steamboat/Sutter Slough, the Delta Cross Channel, and Georgiana Slough, and 3) survival through the entire Delta. I then conducted simulations based on true parameter values and tested the mark-recapture model to ensure the model produced unbiased parameter estimates. Last, I then ran these models with the telemetry data of each study and produced survival route entrainment estimates. Although sample sizes were small, the estimates produced from this study represent a first glance at understanding the movement and survival of juvenile salmon at fine spatial scales in the Delta. For 2007-2008, the next step is to expand the scope of the model to the southern Delta, and apply the model to full-scale field studies.

In years 2 and 3, I analyzed telemetry data from 2008 and 2009 to estimate survival and migration route probabilities. I then used the three years of data to focus on factors affecting survival and entrainment probabilities. For entrainment probabilities, I found that river flow, tidal fluctuations, and Delta Cross Channel gate operations affected the probability of fish entering the interior Delta, where pumping stations are located. The highest probabilities of fish entering the interior Delta occurred during flood tides when the river reversed direction and flowed upstream. As mean river flow declines, tidal forces increasing, thereby increasing the probability of fish entering the interior Delta. Closing the Delta Cross Channel decreased the probability of fish entering the Interior Delta, but by much less than expected given the fraction of flow entering the interior Delta.

I found the survival for fish migrating in the Sacramento River and Sutter and Steamboat Sloughs increased with river flow in the Sacramento River, but survival of fish entering the interior Delta was not significantly related flow variables for the interior Delta. However, sample size was small for the interior Delta, which may have decreased statistical power to detect an effect. Although I found an effect of river flow, there was substantial variability among release groups that could not be explained environmental covariates used in my analysis.
This research has already began to contribute substantially to understanding the survival and movement dynamics of juvenile salmon in the Delta. By coupling acoustic telemetry techniques with the coded wire tag studies, researchers are gaining much more detailed information about local-scale survival and movement of fish through the Delta. This research is helping to understand how both movement through specific routes and survival through those routes interact to affect the survival of the population. Furthermore, the relationships I have quantified between environmental factors, migration routing, and survival form the building blocks of simulation models that managers need to understand how future water management actions will affect movement and survival of juvenile salmon in the Delta.
PUBLICATIONS: List any publications, presentations, or posters that have resulted from this funded research. Give as many details as possible, including status of paper (e.g., in review; in press), journal name, conference location and date of presentation. Please note (as outlined in the conditions of the award) that each fellow is required to submit an abstract for an oral or poster presentation at each State of the Estuary conference and CALFED Science Conference during the duration of the fellowship.

**Publications**

- **Oral Presentation**
  - **Survival and Distribution of Juvenile Chinook Salmon Migrating through the San Joaquin-Sacramento River Delta**
    - American Fisheries Society National Conference
    - San Francisco, CA
    - September 3, 2007

- **Oral Presentation**
  - **Survival and Distribution of Juvenile Chinook Salmon Migrating through the San Joaquin-Sacramento River Delta**
    - DWR and CALFED Meeting
    - Ryde, CA
    - September 6, 2007

- **Poster Presentation**
  - **Estimating Survival and Distribution of Juvenile Chinook Salmon Migrating through the Sacramento ñ San Joaquin River Delta**
    - State of the Estuary Conference
    - Oakland, CA
    - October 15-17, 2007

- **Oral Presentation**
  - **Survival of Juvenile Salmon in the Sacramento-San Joaquin River Delta**
    - CALFED Brown Bag Seminar
    - Sacramento, CA
    - August 20, 2009

- **Feature Article**
  - **Delta Pathways and Outmigrating Salmon Survival Spotlighted**
    - CALFED Science News
    - October, 2009

- **Peer-Reviewed Article**


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**COOPERATING ORGANIZATIONS:** List those agencies and/or persons who provided financial, technical or other assistance to your project since inception. Describe the nature of their collaboration.

CoopOrganiz_15

Steve Lindley, NOAA Fisheries, telemetry database support
Bruce McFarlane, NOAA Fisheries, telemetry study design
Dave Vogel, Natural Resource Scientists, telemetry database support

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**AWARDS:** List any special awards or honors that you, or mentor or members of the research team, have received during the duration of this project.

Awards_16

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**KEYWORDS:** List keywords that will be useful in indexing your project.

Keywords_17
PATENTS: List any patents associated with your project.

Additions: Additional information can be added here. Please begin the text with the number of the question you are adding to.